

**NOTICE !**

**ALL DRAWINGS  
ARE LOCATED  
AT THE END OF  
THE DOCUMENT**

**Woodward-Clyde  
Federal Services****Memorandum**1 of 7  
**DRAFT**

To Neil Holsteen  
EG&G

From Chuan-Mian Zhang 

Office WCFS-Denver

Date Nov 1, 1994

Subject Recommendations about Groundwater Modeling for  
the Rocky Flats, Operable Unit No 6, RFI/RI Report

Within the last two weeks, technical staff at Woodward-Clyde have conducted a preliminary evaluation on groundwater modeling for OU-6, focussing on the groundwater contaminant conditions, the potential sources of contaminants, and appropriate modeling strategies

Groundwater chemicals of concern (COCs) were identified in Technical Memorandum No 4, Human Health Risk Assessment Walnut Creek Priority Drainage, Operable Unit, No 6 (DOE 1994) Based on a review of the spatial distribution and concentrations of these COCs, three major groundwater contaminant problems which potentially need to be modeled were identified

- . TCE and other VOCs in the Trench Area near the landfill pond,
- . Nitrite/nitrate in the North Walnut Creek Drainage at the upgradient of Pond A-1,
- . Vinyl chloride and other volatile organic chemicals (VOCs) in the South Walnut Creek Drainage at the upgradient of Pond B-1

Our evaluation has led to the following conclusions and recommendations

- (1) Modeling of TCE in the Trench Area is being conducted by the S M Stoller Corp , the subcontractor responsible for the OU-7 study,
- (2) Sources of nitrite/nitrate in the North Walnut Creek Drainage are located in the Solar Pond area (OU-4) It is not appropriate for WCFS to perform a groundwater model to cover part of the plume without simulating the sources and the major part of the plume
- (3) A screening level analytical groundwater model may be necessary to simulate potential migration of vinyl chloride from Well 3586 to downgradient This model should be able to simulate both lateral migration in groundwater and volatilization from groundwater to soil gas in vadose zone,
- (4) Measurement of soil gas in the vicinity of Well 3586 is recommended to support groundwater model assumptions and parameter estimation

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- (5) Investigation of potential causes for continuous high concentrations of vinyl chloride in Well 3586 is recommended to support evaluation

Detailed discussion and the rationale for our conclusions and recommendations are presented below

**(1) Trench Area Modeling**

In the Trench Area (IHSSs 166 1, 166 2, 166 3 and 167 3), elevated concentrations of VOCs are found only in wells located on the north side of the groundwater divide, which mimics topographic divide between the North Walnut Creek Drainage and the Unnamed North Tributary Drainage (Figure 1) The flow gradient indicates that contaminants will potentially migrate towards the landfill pond The S M Stoller Corp is currently developing a groundwater model which covers the majority of the Trench Area, including all the trenches mentioned above, except for IHSS 166 2 The wells that have been included in their model domain are 7087, 7287, B206489, B206589, B206689, B206889, 4087, and new wells 76792 and 76992 Among these wells, concentrations of some VOCs and SVOCs are relatively high, the highest of which are found in Well 7287, ranging from 26 to 150 ug/l for TCE

Based on this situation, I do not think that it is not necessary for WCFS to develop another groundwater model to simulate potential contaminant migration

**(2) Nitrite/Nitrate Modeling**

Continuously high concentrations of nitrite/nitrate have been observed in valley fill wells and bedrock wells (having hydraulic communication with valley fill wells) in the area upgradient of the A-series ponds These wells are 1786, 1586, B208589, B210489, B206989, B208289, B209689 and P210089, with concentrations ranging from 30 to 1,700 mg/l within the data window of 1st quarter 1991 to 4th quarter 1993 (Figure 2, the last four wells not shown in figure yet)

Evidence presented in 1991 Annual RCRA Groundwater Monitoring Report for Regulated Units at Rocky Flats Plant (EG&G 1992) indicates that sources of nitrite/nitrate are located within the solar pond area, as OU-4 The elevated groundwater concentrations in North Walnut Creek area are only the front of nitrate/nitrite plume The majority of the plume is within the area of OU-4

It is recommend that a complete groundwater model should be developed to cover both OU-4 and part of OU-6 area to simulate the entire nitrate/nitrite plume It is not appropriate for WCFS to develop a model only covering the contaminant front However, the evaluation of nitrite/nitrate migration will be discussed in RFI/RI report

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### **(3) Vinyl Chloride Modeling**

High concentrations of vinyl chloride (VC), ranging from 200 to 860 ug/l, have been continuously observed in Well 3586 (screened in valley fill alluvium). However, no VC has been detected in upgradient or downgradient wells. No VOCs were detected in Well 3686, also screened in valley fill alluvium and located approximately 600 ft downgradient, during the period of data window (1st quarter 1991 to 4th quarter 1994), as shown in Figure 3.

At this stage of the evaluation, the following unknowns remain: (1) what causes the isolated high concentration of VC in Well 3586, and, (2) if there is potential for VC to migrate downgradient. In general, the subsurface environment is not likely to be favorable for biotransformation from parent products (e.g., PCE, or 1,1,1-TCA) to VC, which is evidenced by low concentrations of VC being observed at limited local locations in OU-2. Since there is a sewage treatment plant in the surrounding area, it is suspected that the potential causes for the isolated high concentrations of VC may be related to this sewage treatment plant. Further investigations for the potential sources of bacteria, or direct VC released to the site, and the biotransformation processes for VC are necessary.

Evaluation of the potential for fate and transport of VC could be performed by a simple analytical groundwater model. This model should be able to incorporate both groundwater transport and volatilization. It is suspected that volatilization may be the reason that VC has not been found in the downgradient well. The suspicion is based on the following reasons: (1) VC has great potential to be volatilized, having a Henry's law constant of  $1.22 \text{ atm}\cdot\text{m}^3/\text{mol}$  at  $10^\circ\text{C}$  (Montgomery and Welkom 1989), (2) the water table in the valley fill alluvium in the vicinity of Well 3586 is shallow, with an average depth of 8 ft, (3) observations recorded during the 4th quarter of 1993 sampling at Well 3586 show very high gas concentrations of VOC, with initial head space concentration of 104 mg/l and 2.8 mg/l about 5 minutes later, the latter of which may represent the volatilization rate under ambient conditions.

A simple one-dimensional analytical groundwater model that can incorporate both mechanisms, lateral migration in groundwater and volatilization in vadose zone, has been developed by WCFS, since such an analytical groundwater model is not available in the literature to our knowledge. The developed model includes only the most important fate and transport process (for our interest): advection in groundwater system, and volatilization in vadose zone. Adsorption and biodegradation were ignored based on the physical and chemical properties of VC. Dispersion was also ignored because one-dimensional dispersion only causes attenuation. If the source concentration is constant, dispersion will only delay the process for the downgradient concentration to approach that constant.

In order to ensure that the developed model is correct and acceptable to review agencies, independent peer review by a groundwater modeling expert with national recognition is recommended. The peer review process is expected to be a simple and short process, because the model is a very simple one.

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The potential migration of estimation using the developed model depends on some critical parameters, (e g , the Henry's law constant (different values from different literature), air-filled porosity in vadose zone, etc ) Therefore reasonableness checking is necessary It is recommended that soil gas measurements in the vicinity of Wells 3586 and 3686 be performed to check if our assumption that volatilization is an important fate process for VC is true This field work should be conducted as soon as possible because it is a dry season currently, thus providing an opportunity for volatilization The results will support the assumptions and provide insight for a better understanding of the associated parameters WCFS will develop a plan for performing soil gas measurements in the area, should EG&G follow this recommendation

## References

Montgomery, J H and L M Welkom, 1989 Groundwater Chemicals Desk Reference

U S Department of Energy (DOE) 1994 Technical Memorandum No 4, Chemicals of Concern, Human Health Risk Assessment Walnut Creek Priority Drainage, Operable Unit 6, Draft, Rocky Flats Plant, U S Department of Energy, Rocky Flats Plant, Golden, Colorado, July 1994

EG&G Rocky Flats, Incorporated, 1992 1991 Annual RCRA Groundwater Monitoring Report For Regulated Units at Rocky Flats Plant, Volume I, March 1, 1992

cc Mary Lee Hogg, EG&G  
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### EXPLANATION

# INDIVIDUAL HAZARDOUS SUBSTANCE SITES

**UHSU MONITORING WELL  
(ALLUVIAL)**

**B206889 • UHSU MONITORING WELL (BEDROCK)**

UHSU = UPPER HYDROSTRATIGRAPHIC UNIT

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0586 — LOCATION

2/26/92      ▲      SAMPLE DATE

                 ▲      ANALYTE

                 ▲      ANALYTE CONCENTRATION (ug/l) LAB QUALIFIERS AND VALIDATION CODES

(V) - VOLATILE

## NOTES

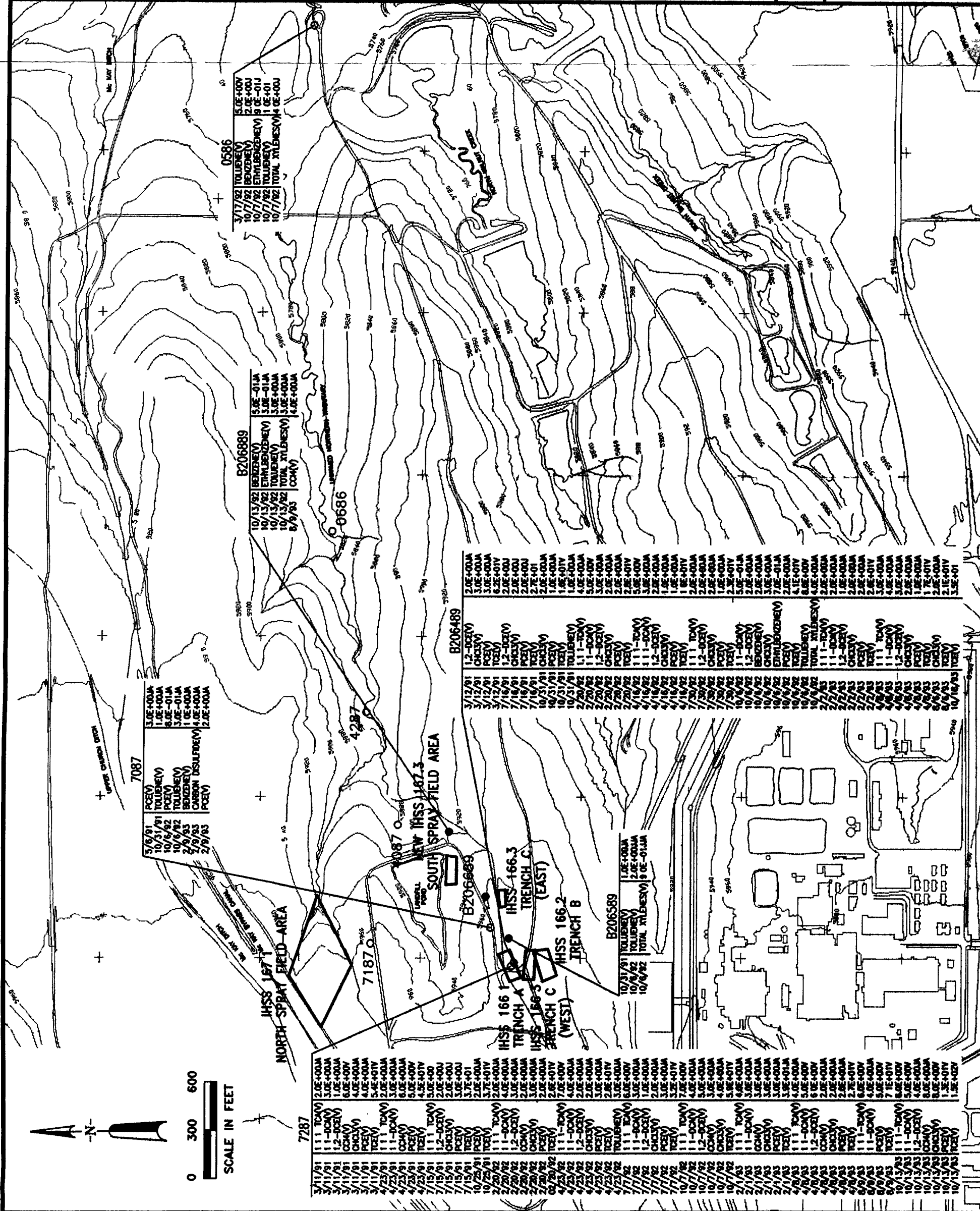
- 1 ALL ANALYTE CONCENTRATIONS ARE REPORTED IN ug/l (parts per billion) ANALYTE ABBREVIATIONS LAB QUALIFIERS AND VALIDATION CODES ARE PRESENTED ON FIGURE 4-2-1
- 2 ALL LOCATIONS SHOWN ON THIS MAP WERE SAMPLED RESULTS ARE SHOWN ONLY WHERE THE CHEMICALS WERE DETECTED
- INDICATES THIS RESULT IS AN AVERAGE OF THE REAL AND DUPLICATE SAMPLE RESULTS

**U S DEPARTMENT OF ENERGY  
Rocky Flats Plant Golden Colorado**

OPERABLE UNIT NO 6  
PHASE I RF1/R1 REPORT

**ORGANIC COMPOUNDS  
AREA 1 (UNNAMED TRIBUTARY DRAINAGE)  
UHSU GROUNDWATER  
1st QUARTER 1991 - 4th QUARTER 1991**

FIGURE 10



EXPLANATION

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INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES



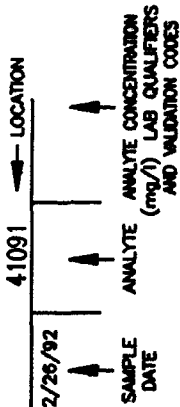
UHSU MONITORING WELL  
(ALLUVIAL)

UHSU MONITORING WELL  
(COLLUVIAL)

UHSU MONITORING WELL  
(BEDROCK)

UHSU = UPPER HYDROSTRATIGRAPHIC  
UNIT

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NOTES

- 1 ALL ANALYTE CONCENTRATIONS ARE REPORTED IN mg/l (parts per million) ANALYTE ABBREVIATIONS LAB QUALIFIERS AND VALIDATION CODES ARE PRESENTED ON FIGURE 4-2-1
- 2 ALL LOCATIONS SHOWN ON THIS MAP WERE SAMPLED RESULTS ARE SHOWN ONLY WHERE THE CHEMICALS WERE DETECTED
- INDICATES THIS RESULT IS AN AVERAGE OF THE REAL AND DUPLICATE SAMPLE RESULTS

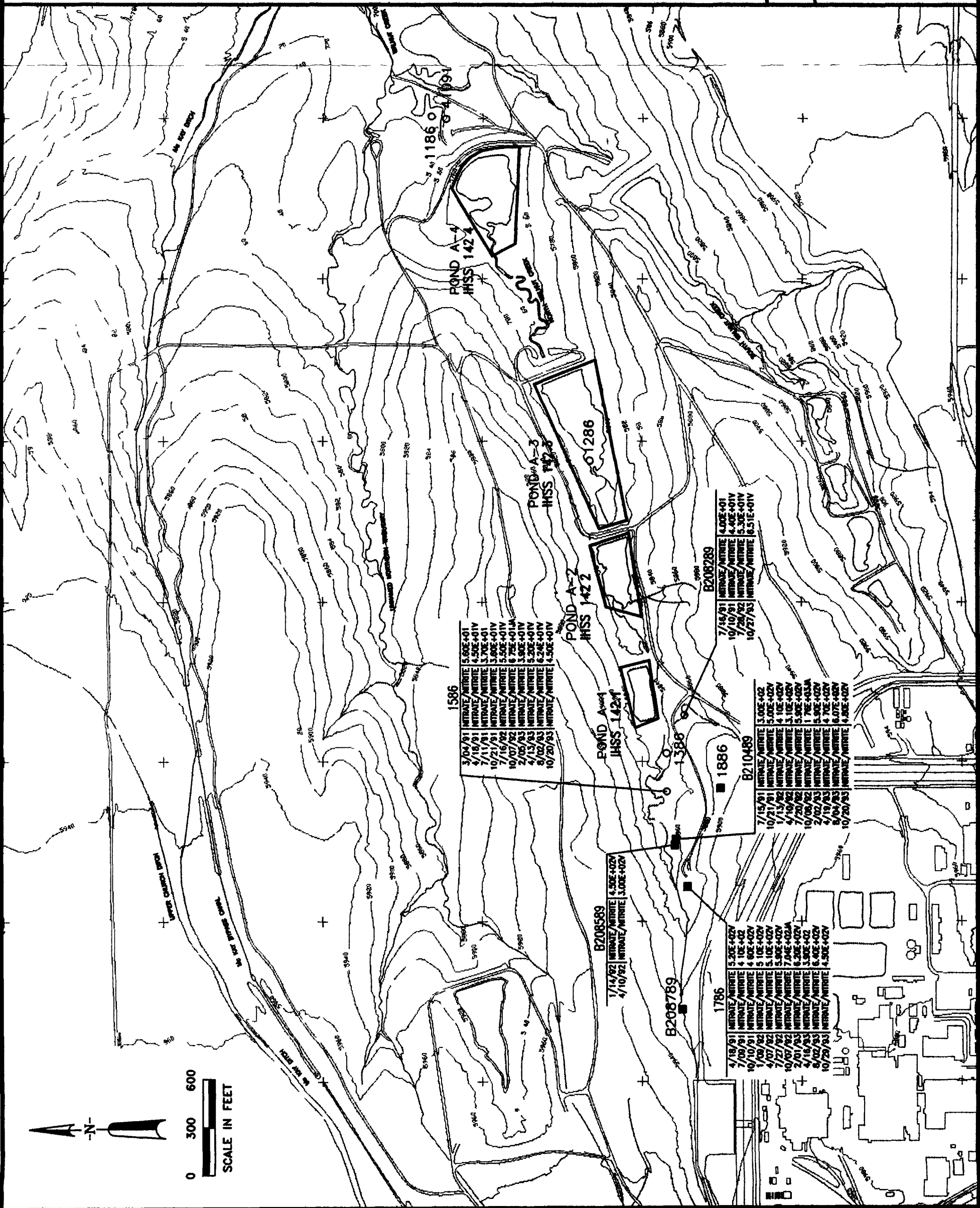
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OPERABLE UNIT NO 6  
PHASE I RFI/RI REPORT

NITRATE/NITRITE  
AREA 2 (NORTH WALNUT CREEK DRAINAGE)  
UHSU GROUNDWATER  
1st QUARTER 1991 - 4th QUARTER 1993

2.0

FIGURE 4-6-15 AUGUST 1994  
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EXPLANATION

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INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

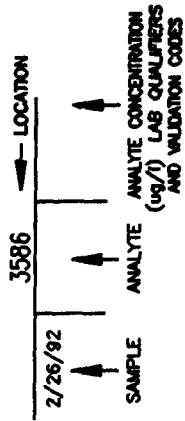


3586 ○ MONITORING WELL  
(ALLUVIAL)

02691 ● MONITORING WELL  
(BEDROCK)

UHSU = UPPER HYDROSTRATIGRAPHIC  
UNIT

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(V) - VOLATILE

NOTES

- 1 ALL ANALYTE CONCENTRATIONS ARE REPORTED IN ug/l (parts per billion) ANALYTE ABBREVIATIONS LAB QUALIFIERS AND VALIDATION CODES ARE PRESENTED ON FIGURE 4-2-1
  - 2 ALL LOCATIONS SHOWN ON THIS MAP WERE SAMPLED. RESULTS ARE SHOWN ONLY WHERE THE CHEMICALS WERE DETECTED
  - 3 PESTICIDE/PCB ANALYSES WERE PERFORMED AT ONLY LOCATION 02691
- INDICATES THIS RESULT IS AN AVERAGE OF THE REAL AND DUPLICATE SAMPLE RESULTS

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OPERABLE UNIT NO 6  
PHASE I RFI/RI REPORT

ORGANIC COMPOUNDS  
AREA 3 (SOUTH WALNUT CREEK DRAINAGE)  
UHSU GROUNDWATER  
1st QUARTER 1991 - 4th QUARTER 1993

30  
FIGURE 4-6-17

AUGUST 1994

8/29/94

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